Factors of Digital Leadership for Basic Educational Administrators in Nonthaburi Province, Thailand

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Abstract

The objective of this research was to study digital leadership by exploratory and confirmatory factor analysis of digital leadership for basic educational administrators in Nonthaburi Province, Thailand. The researcher used a constructed questionnaire with content validity between .67-1.00 and reliability value of .91. The sample was 400 teachers selected by stratified random sampling by school sizes. The data were analyzed by percentages, means, standard deviation and factor analysis. The results were: (1) The digital leadership for basic educational administrators in Nonthaburi Province in total was at the high level: the highest was *visionary leadership*, followed by *talent management*, *professional practice*, *data driven*, and *digital age learning culture*. (2) The exploratory factor analysis revealed 4 factors. The first factor was *creation of innovative digital leadership,* followed by *visionary leadership*, *data driven,* and *professional practice*, respectively. (3) The confirmatory factor analysis indicated the fit of empirical data with (χ^2 /df) = 2.00 CFI=.89, RMSEA=.047, CN=254, largest standardized residual=.20. It is expected that the obtained findings on the identified factors can be used as guidelines for human resource training in support of digital leadership in schools under the Basic Education Office at the provincial and national levels.

Keywords: Digital leadership, basic education, school administrators, factor analysis

1. Introduction

Advances in digital technology require changing work patterns and processes. Especially with school administrators, it is necessary to know and have digital skills to keep up with the rapid changes. The digital technology is considered an important tool and method in current management. School leaders have their role in leading and mentoring teachers and learners. Educational institutions need digital technology to deliver learning management, including having a digital media library so that students can access it to develop themselves anytime, anywhere. Chaemchoi (2019) asserted that currently, technology not only plays a role in life, but also has an influence on learning management for students in educational institutions in a holistic manner, whether it is on a smartphone, tablet, or notebook. When these devices are connected to the Internet, it will result in learning that is limitless in terms of time, place, and the amount of knowledge that students can access from all over the world. The evolution of these

technologies has led to new forms of learning for students. In this regard, administrators of educational institutions need to adjust their operations and learning management to be appropriate for the direction of the era in support of learning autonomy. The current context of Thai educational institutions requires modern technology that is convenient, quick, and easy to use (Petchroj, L. (2021a).

As for teachers' teaching and learning organization in the digital age, the creation of innovative digital media for education has been in place, such as new media in 3D format, animation, and artificial intelligence (AI) as new products and services. Digital innovation is used to meet the needs of teaching and learning that adapt to the context of rapidly changing educational requirements. Therefore, the implementation of digital technology should begin by setting clear goals for ongoing and future education management in the first place. Then educational leaders can set a strategy on applying appropriate digital innovation technology to align with the educational institution's vision and mission. All of these tasks certainly depend on the leadership of school executives. Their ultimate goal apparently rests upon how to support students' learning autonomy toward the expected outcomes to be able to further their study at a higher level, entering the job market with required competencies, and continue to function as quality human resources for target professional fields and industries.

2. Background of the Study

Digital Technology

The digital technology utilizes information via electronic media both online and offline formats. Teachers and students with digital literacy skills can benefit from access to information sources as desired. Therefore, school administrators must provide for teaching and learning media and skills training in using technology via academic in-services. Teachers and students need both main and supplementary media, as well as suitable e-learning platforms. These are added to the normal teaching and learning management system. Learning through electronic media can be organized in many formats, such as online-offline format, education via website learning through mobile phones (m-Learning) and multimedia (Multimedia), which combine various types of media altogether. Learners must learn and adapt to keep up with current information skills. They can freely search through the web and even create their own web page. They can practice through e-books and interact with groups, while selecting at will--blog, podcast, webcast, YouTube, Wikis, Skype, and Line, for information search, learning and sharing.

Learners' Abilities

Learners' abilities can be divided into three dimensions. The first deals with fluency in use. Essential techniques for using computers and the internet skills range from basic techniques for using computer programs, such as word processors, web browsers, e-mail, and other communication tools, to more advanced techniques for accessing and using knowledge, such as programs that help in searching for information and accessing online databases, including cloud computing. The second dimension involves a set of skills to help learners understand the context and evaluate digital media. The third

supports creation with an emphasis on the ability to produce content and communicate effectively through a variety of digital media tools. Students are trained to create contents for communication in different contexts by using rich media, such as images, videos and audios, as well as creating efficiently, such as blogs and image sharing, videos, social media, and other formats (Media Smarts, 2015).

Digital Leadership

Digital Leadership can be referred to as a mindset and relevant skills that will allow individuals or organizations to lead other members of the organization to survive in the digital age. Leadership skills essentially required in the digital age focus on adaptability to use technology Buachu & Buachu (2019). Digital leadership includes the characteristics, knowledge, skills, abilities, and behaviors in school directors or leaders who can influence teachers and personnel in the school context. In general administration, personnel management, academic administration, and budget management, staffs need to have clear understanding of access and use in digital technology at work. Education with technological changes and the new concept of organizing education in a crisis situation, prompt schools to adapt the use of various digital platforms for online teaching, such as Tencent Live Streaming, Google Hangout Meet, Google Classroom, Microsoft Team, Class Start, and Zoom. These platforms enable administrators, teachers and students to work efficiently toward the identified mission and goal.

Basic Education Teacher Training in Nonthaburi, Thailand

Basic education in Thailand is for students for at least 12 years before entering higher education. As specified by the Ministry of Education, there are three levels: pre-primary education (6 years), primary education (3 years), and secondary education (3 years). Teacher training is provided at the higher education level. In this study, Rajapruk University as a higher-education institution is involved in basic education teacher training by offering a graduate program in education. The Master of Education Program has more than 80 percent of registered students who are educational administrators, heads of departments, and teachers in Nonthaburi Province. The program organizes academic activities in collaboration with educational institutions in Nonthaburi Province in the school mentoring project in cooperation with the Nonthaburi Provincial Administrative Organization Office. The subject of professional training in educational administration is of prime importance, including training in research potential development, creating innovative media, developing teaching and learning management capabilities, measurement and evaluation, updated academic and research skills, along with change strategies in education management technology. It should be noted that the past situation of COVID-19 in 2020-2023 has prompted educational administrators to use various technology platforms for online teaching and learning.

3. The Study

Considering *changing technology and individual learning styles* in the digital age and beyond in higher education as affecting the quality of education administration, the researcher would like to find out a model in learning administration in Thai basic education in the digital age, as perceived by educators concerned. It was expected that the obtained findings could benefit short- and long-term planning for faculty members and

students in educational institutions in line with changes from the disruption of the digital revolution in all areas of education and industry.

In this study, the researcher aimed to identify the factors of digital leadership for educational administrators in basic education institutions in Nonthaburi Province. It was expected that the obtained findings would generate guidelines for academic content design and implementation regarding the roles of digital leadership administrators in coping with changes in educational practices imposed by the digital revolution.

4. Research Objective

The objective of this research was to study digital leadership by exploratory and confirmatory factor analysis of digital leadership for basic educational administrators in Nonthaburi Province, Thailand. The obtained findings were expected to generate guidelines for basic education administrators to adjust their role in coping with changes in educational operations imposed by the digital revolution.

5. Conceptual Framework

The conceptual framework in this study was based on digital technology to enhance educational administration tasks as follows:

(1) Digital technology can support on the spur of educational changes, particularly *administration process* in teaching and learning, research, academic services, and art and culture promotion. The conceptualization of digital learning and digital citizens will generate new teaching and learning modes via information communication technology (ICT) (Petchroj, 2022).

(2) In Thailand, ICT is considered one of the main elements in integrating information systems for modern education via networking and online courses (Suchato, 2017).

(3) Leadership in the digital economy era aims at sustainable development of educational organizations with visionary leadership and digital learning culture. Digital skills and sustainable development determine administrative competencies in the 21st century for efficient leaders in the field of education (Chaemchoi, 2019).

6. Research Methodology

The population consists of 2,254 teachers: (i) 1,723 secondary school teachers under Nonthaburi Secondary Educational Service Area Office, and (ii) 531 primary school teachers under Nonthaburi Primary Educational Service Area Office Area 1 (n=162) and Area 2 (n=369).

The sample was 400 selected by stratified random sampling: 307 secondary teachers, and 93 primary teachers. All selected participants hold qualifications for administrative positions as specified by the Basic Education Office in Nonthaburi Province, and have educational management experience at the school level for at least five years. It should be noted that the gender variable is not considered for its impact on the participants' perception toward digital leadership of education administrators in this study. By school arrangements, the participants provided their responses to the survey questionnaire online in the first quarter of 2024.

The research instrument was an online survey questionnaire to collect data on the respondents' opinions on digital leadership of education administrators in six aspects: (i) Overall, (ii) Visionary Leadership, (iii) Professional Practice, (iv) Data Driven, (v) Talent Management, and (vi) Digital Age Learning Culture. The question items were based on the six aspects of digital leadership, on a scale of 1 low to 5 high. The constructed questionnaire was validated by three experts in educational administration for IOC value in each item between .67-1.00, having reliability of Cronbach' alpha co-efficient .91. The data analysis used percentages, means, standard deviation, factor analysis in two types: exploratory factor analysis and confirmatory factor analysis.

The researcher used statistics to measure consistency as follows:

(1) A chi-square value that is not statistically significant is a p-value higher than .05.

(2) The chi-square ratio/degrees of freedom (χ^2 / df) value should not exceed 2.00.

(3) Goodness of fit index: GFI, adjusted goodness of fit index: AGFI, comparative fit index: CFI has values from 0.90-1.00.

(4) The standardized root mean squared residual: standardized RMR, root mean square of error approximation: RMSEA values are lower than .05.

(5) The critical n: CN value is equal to or greater than 200 of the sample.

(6) The largest standardized residual has a value of -2 to 2.

7. Data Analysis

This section reports the results of the study in two parts. The first part is on the respondents' opinions on digital leadership of education administrators in six aspects: (i) Overall, (ii) Visionary Leadership (a), (iii) Professional Practice) (b), (iv) Data Driven (c), (v) Talent Management (d), and (vi) Digital Age Learning Culture (e) (see Tables 1-7). The second part shows the results from exploratory and confirmatory factor analyses (see Figures 1 and 2).

7.1 Respondents' Opinions on Digital Leadership for Educational Administrators of Basic Educational Institutions in Nonthaburi Province

Table 1 shows that the mean and standard deviation of the digital leadership opinions in *Overall* at a high level ($\bar{x}$ = 4.19, SD =.47). When considering each aspect, every aspect had an average level of high and the highest levels. The aspect with the highest mean value was *Visionary leadership* at the highest level ($\bar{x}$ = 4.61, SD=.54), followed by *Professional practice*, *Data driven*, *Digital age learning culture* and *Talent management*, respectively.

Table 1: Respondents' Opinions on Digital Leadership for Education Administrators *Overall*: Mean and Standard Deviation (N=400)

Aspect	Description	$\bar{x}$	SD	Meaning	Rank
1	Visionary Leadership) (a)	4.61	.54	highest	1
2	Professional Practice) (b)	4.16	.56	high	2
3	Data Driven (c)	3.97	.66	high	3
4	Talent management) (d)	3.31	.56	high	5
5	Digital Age Learning Culture (e)	3.91	.67	high	4
	Total	4.19	.47	high	

Table 2 reports the respondents' opinions on digital leadership of education administrators in *Visionary leadership* with the total at a highest level and four items at the highest level. The highest number was *Apply digital to enhance organizational excellence*. The lower numbers were *Able to exchange and convey visions with personnel thoroughly*, *Have an idea about organizational transformation through the development of digital innovation,* and *Have an understanding of strategies that support your goals will increase your chances of competing*.

Table 2: Respondents' Opinions on Digital Leadership for Education Administrators *Visionary Leadership(a)*: Mean and Standard Deviation (N=400)

Item	Visionary Leadership) (a)	$\bar{x}$	SD	Meaning	Rank
a1	Able to exchange and convey visions with personnel thoroughly.	4.63	.58	highest	2
a2	Have an idea about organizational transformation through the development of digital innovation.	4.58	.59	highest	3
a3	Apply digital to enhance organizational excellence.	4.68	.57	highest	1
a4	Have an understanding of strategies that support your goals will increase your chances of competing.	4.57	.75	highest	4
	Total	4.61	.54	highest	

Table 3 shows all items at a high level; the highest aspect was *School administrators are leaders in being fluent in digital usage.* The lower aspects were *Able to organize a professional digital innovation learning environment, Able to organize a professional digital innovation learning environment*, and *Belief in using technology in the digital age and searching for various digital learning resources*.

Table 3: Respondents' Opinions on Digital Leadership for Education Administrators *Professional Practice) (b)*: Mean and Standard Deviation (N=400)

Item	Professional Practice) (b)	$\bar{x}$	SD	Meaning	Rank
b1	School administrators are leaders in being fluent in digital usage.	4.36	.67	highest	1
b2	Belief in using technology in the digital age.	4.21	.77	high	3
b3	Able to organize a professional digital innovation learning environment.	4.26	.72	high	2
b4	Searching for various digital learning resources.	3.79	1.05	high	4
	Total	4.16	.56	high	

Table 4 indicates that all items were at a high level; the highest aspect was *Able to retrieve information using technology*. The lower aspects were *Strategic planning of quality data management, Use information resources with technology effectively*, and *Use information in management to achieve maximum benefit.*

Table 4: Respondents' Opinions on Digital Leadership for Education Administrators *Data Driven (c)*: Mean and Standard Deviation (N=400)

Item	Data Driven (c)	$\bar{x}$	SD	Meaning	Rank
c1	Strategic planning of quality data management	4.00	.73	high	2
c2	Able to retrieve information using technology	4.05	.76	high	1
c3	Use information resources with technology effectively	3.95	.89	high	3
c4	Use information in management to achieve maximum benefit.	3.89	.85	high	4
	Total	3.97	.66	high	

Table 5 reveals that all items were at a high level; the highest number was *Able to manage the recruitment of talented, quality personnel for educational institutions*. The lower aspects were *Develop personnel with knowledge and innovative ideas*, *Able to develop creative thinking in digital innovation for teachers and students,* and *Manage and balance the skills and abilities of personnel to suit the situation.*

Table 5: Respondents' Opinions on Digital Leadership for Education Administrators *Talent Management (d)*: Mean and Standard Deviation (N=400)

Item	Talent Management (d)	$\bar{x}$	SD	Meaning	Rank
d1	Manage and balance the skills and abilities of personnel to suit the situation.	4.05	.83	high	4
d2	Able to manage the recruitment of talented, quality personnel for educational institutions	4.42	.59	high	1
d3	Able to develop creative thinking in digital innovation for teachers and students	4.37	.67	high	3
d4	Develop personnel with knowledge and innovative ideas	4.41	.60	high	2
	Total	4.31	.56	high	

Table 6 showed that all items at a high level; the highest number was *Create dynamics in using technology Digital innovation normalized in educational institutions*. The lower aspects were *Support and encourage all personnel to have access to digital innovation*, *Create a culture of learning in the digital world in educational institutions*, and *Promote mutual learning in the digital world until it is adhered to as a practice.*

Table 6: Respondents' Opinions on Digital Leadership for Education Administrators *Digital Age Learning Culture (e)*: Mean and Standard Deviation (N=400)

Item	Digital Age Learning Culture (e)	$\bar{x}$	SD	Meaning	Rank
e1	Create dynamics in using technology Digital innovation normalized in educational institutions	4.21	.69	high	1
e2	Create a culture of learning in the digital world in educational institutions.	3.84	.94	high	3
e3	Support and encourage all personnel to have access to digital innovation.	3.95	.67	high	2
e4	Promote mutual learning in the digital world until it is adhered to as a practice	3.58	.82	high	4
	Total	3.89	.67	high	

7.2 Results of Exploratory Factor Analysis

Table 7 reveals a total of four factors, each factor having at least 3 variables, with the weight of Factor Loading between .595 to.949. The factors are shown below:

Table 7: Factor Loading of Exploratory Elements after Rotation

Rotated Component Matrix[a]

Item	Factor Loading			
	1	2	3	4
e1) Create dynamics in using technology Digital innovation normalized in educational institutions	.935			
d4) Develop personnel with knowledge and innovative ideas	.834			
e2) Create a culture of learning in the digital world in educational institutions.	.722	.		
c1) Strategic planning of quality data management	.700			
d2) Able to manage the recruitment of talented, quality personnel for educational institutions	.640			
a2) Have an idea about organizational transformation through the development of digital innovation.		.949		
a1) Able to exchange and convey visions with personnel thoroughly.		.889		
a3) Apply digital to enhance organizational excellence		.831		
a4) Have an understanding of strategies that support your goals will increase your chances of competing.		.719		
C2) Able to retrieve information using technology.			.911	
c3) Use information resources with technology effectively.			.872	
c4) Use information in management to achieve maximum benefit.	.		.595	
b1) School administrators are leaders in being fluent in digital usage.				.880
b2) Belief in using technology in the digital age.				.789
b3) Able to organize a professional digital innovation learning environment.				.744
Eigen Value	6.552	2.885	1.737	1.271

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
[a.] Rotation converged in 6 iterations

As seen in Table 7, Factor 1 had an Eigen Value of 6.552, consisting of 4 variables of executives: *'Create dynamics in using technology Digital innovation normalized in educational institutions'* (e1), *'Develop personnel with knowledge and innovative ideas' (d4), 'Create a culture of learning in the digital world in educational institutions'* (e2), 'Strategic planning of quality data management' (c1) and *'Able to manage the recruitment of talented, quality personnel for educational institutions'* (d2). Therefore, the name of this digital leadership factor was "Components of Creation of Innovative Digital Leadership."

Factor 2 had an Eigen Value of 2.885, consisting of 4 variables of executives: *'Have an idea about organizational transformation through the development of digital innovation'* (a2), *'Able to exchange and convey visions with personnel thoroughly'* (a1), *'Apply digital to enhance organizational excellence'* (a3), and *'Have an understanding of strategies that support your goals will increase your chances of competing'* (a4). This factor was therefore named "Components of having a Visionary Leadership."

Factor 3 had an Eigen Value of 1.737, consisting of 3 variables of executives: *'Able to retrieve information using technology'* (c2), *'Use information resources with technology effectively'* (c3), and *'Use information in management to achieve maximum benefit'* (c4). This factor was named "Components of the ability to use information systems using Data Driven"

Factor 4 had an Eigen Value of 1.271 consisting of 3 variables of executives: *'School administrators are leaders in being fluent in digital usage'* (b1), *'Belief in using technology in the digital age'* (b2), and *'Able to organize a professional digital innovation learning environment'* (b3). Therefore, this factor was named "Components of being a professional and fluent digital using Professional Practice."

7.3 Results of Confirmatory Factor Analysis

The structure appears in Figures 2 and 3 as follows:

(1) Chi-square values not statistically significant are p-values higher than 0.05 (not consistent with the value obtained at .005).

(2) The chi-square ratio/degrees of freedom ($\chi2$ / df) value should not exceed 2.00 (corresponds to the value obtained at 2.00).

(3) Goodness of fit index: GFI, adjusted goodness of fit index: AGFI, comparative fit index: CFI with values from 0.90 – 1.00 (corresponding to the value obtained .89)

(4) The standardized root mean squared residual: standardized RMR, root mean square of error approximation: RMSEA values are lower than 0.05 (corresponding to the obtained value .047).

(5) The critical n: CN value is equal to or greater than 200 of the samples (corresponding to 254).

(6) The largest standardized residual has a value of -2 to 2 (corresponds to .20).

Figure 1: Results of Confirmatory Factor Analysis (1)
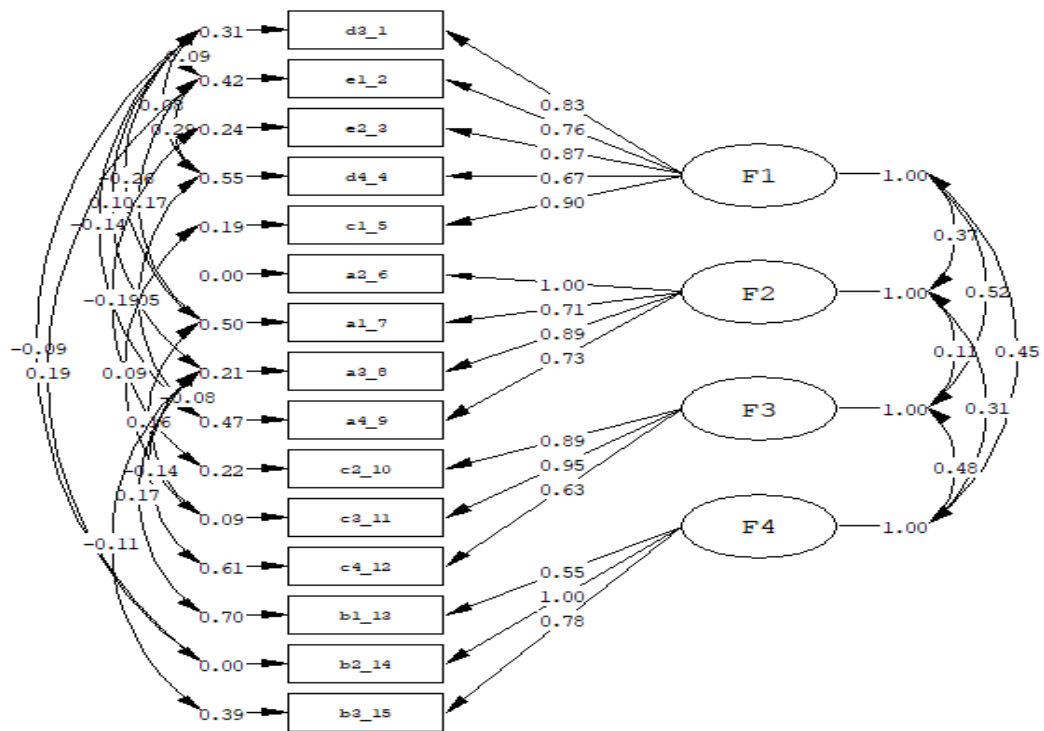
Chi-square=190.60, df = 95, p-value=.045, RMSEA=.047

Figure 2: Results of Confirmatory Factor Analysis (2)
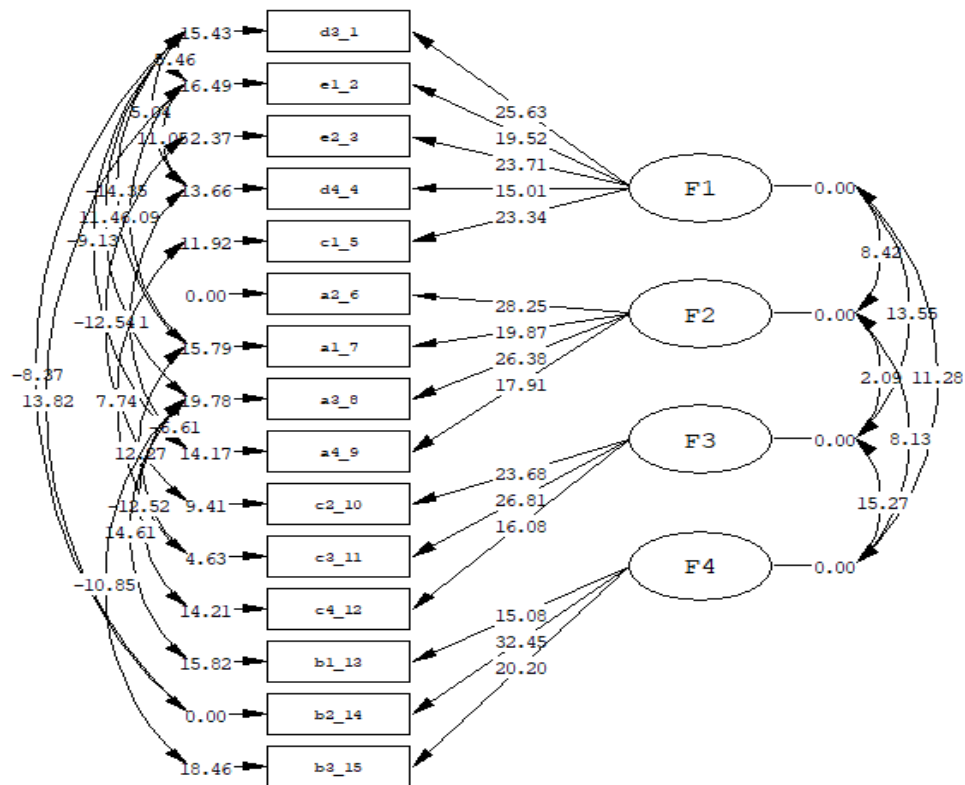
8. Conclusion and Discussion of Research Results

The conclusion and discussion of the research results are responsive to the identified research objective: to study digital leadership by exploratory and confirmatory factor analysis of digital leadership for basic educational administrators in Nonthaburi Province, Thailand. The researcher expected that the obtained findings on the identified factors can provide guidelines for training in digital leadership development in schools under the Basic Education Office at the provincial and national levels in Thailand. The major findings are concluded and discussed in this section:

(1) The digital leadership opinions in *Overall* were at a high level. When considering each aspect, the highest mean was *Visionary Leadership* at the highest level, followed by the high level by *Professional Practice*, *Data Driven*, *Digital Age Learning Culture*, and *Talent Management*, respectively. The researcher also performed exploratory and confirmatory factor analyses on the obtained data and found four factors: (i) Creation of Innovative Digital Leadership (ii) Visionary Leadership (iii) Data Driven, and (iv) Professional Practice. The findings are discussed in this section.

(2) From the findings derived from the respondents' opinions on digital leadership for educational administrators in basic education in Nonthaburi Province, *Visionary Leadership* was identified as the most prominent aspect. This aspect appears to stem from the rapidly changing technology in the digital era. It has become an important tool and method for management; therefore, administrators need to adapt themselves to cope with rapid changes from digital disruption, and accommodate their human resources--teachers and students to use modern technology conveniently, quickly, and easily. Teachers must be trained and supported to organize effective learning management, create innovative digital media for education, such as new media in 3D, animation, and artificial intelligence (AI). They must apply digital technology to meet the needs of new modes for teaching and learning management. This is consistent with Buachu & Buachu (2019) who concluded that digital leadership of school directors can have direct impacts on teachers and educational personnel in schools in all areas of administration: registration and documentation, personnel management, academic task execution, and budget and finance. School leaders must be digitally literate--understand, be able to create, access, and use digital innovation technology in school administration. They need to handle educational management in crisis, as in the past situation of COVID-19, by adapting online platforms for teaching and learning. This finding also aligns with the earlier research by Kantham & Thammaphisamai (2018) that emphasized four main components in the digital leadership measurement model: (i) Communication skills, (ii) Creative thinking skills, (iii) Vision skills, and (iv) Cooperation skills—all these in support of digital leadership at the school and university levels.

(3) From the results of exploratory and confirmatory factor analyses, four factors are evident to be integrated into the guidelines for digital leadership of educational administrators in basic education institutions in Nonthaburi Province. These four factors are: (i) Creation of Innovative Digital Leadership (ii) Visionary Leadership (iii) Data Driven (iv) Professional Practice.

Creation of Innovative Digital Leadership as Factor 1 consists of five variables: (i) Create dynamics in using technology Digital innovation normalized in educational institutions, (ii) Develop personnel with knowledge and innovative ideas, (iii) Create a culture of learning in the digital world in educational institutions, (iv) Strategic planning of quality data management, (v) Able to manage the recruitment of talented, quality personnel for educational institutions. As known, the creation of digital innovation is a necessity that administrators must adapt to suit the context of each school, which has different readiness in terms of teachers' and students' abilities, and the modernity of technology and budget. Differences in school contexts were earlier emphasized by Suwannarat (2020) who also studied digital leadership for school administrators under the Nonthaburi Secondary Educational Service Area Office. This researcher especially pointed to the significance of personnel assessment in digital knowledge and skills in the organization, and the use of digital technology in evaluating the entire digital technology systems selected by individual secondary school contexts.

Visionary Leadership as Factor 2 consists of 4 variables: (i) Have an idea about organizational transformation through the development of digital innovation, (ii) Able to exchange and convey visions with personnel thoroughly, (iii) Apply digital to enhance organizational excellence, (iv) Have an understanding of strategies that support your goals. School administrators need to adapt themselves to online teaching and learning, using media and technology skills--both for in-class instruction and supplementary media. An emphasis should be on the use of electronic media (e-Learning) in various forms, such as online, offline, studying via websites, learning via mobile phones (m-Learning), mixed media (Multi Media), which is the use of various types of media altogether. Learners must develop information skills by searching via the Web and creating Webpages, assessing understanding by taking online quizzes and supplementary practices via e-books, and interacting with groups, Vlog, Podcast, Webcasts, You Tube, Wikis, Skype by various computer media available (Petchroj, 2021a).

Data Driven as Factor 3 consists of 3 variables: (i) Able to retrieve information using technology, (ii) Use information resources with technology effectively, and (iii) Use information in management to achieve maximum benefit. This factor gives significance to the information system and technology regarding quick and easy access. The Ministry of Education Policy (announced in 2016) has set management standards and educational institution development as a model for the use of information technology (ICT) to develop autonomous and life-long learning nationwide. In terms of internal management of educational institutions, the information technology development plan must be included in the annual action plan on the Internet/LAN network system in educational institutions. Teachers can use information technology to organize learning activities for students effectively. Such requirement appears consistent with the study by Domeny (2017) in support of the relationship between digital leadership of school administrators and that of teachers in elementary schools in Missouri, USA. The researcher asserted that the level of digital leadership of administrators is closely associated with teachers' self-awareness in the created skill model by the ISTE standard for administrators.

Professional Practice as Factor 4 consists of 3 variables: (i) School administrators are leaders in being fluent in digital usage, (ii) Belief in using technology in the digital age, and (iii) Able to organize a professional digital innovation learning. As required, administrators need to develop the characteristics of educational institution administrators in the digital era. ICT Leadership means the ability of administrators to learn, understand, accept changes in ICT, be able to apply it appropriately and create the most benefit to their educational institution. This is consistent with the research of Petchroj (2021b) and Ridho et al. (2023) in that digital leadership is in the scope of education management. In the era of Industrial Revolution 4.0 or the first phase of digital revolution, educational administrators need to update and adapt policies, plans, and development principles to changes caused by digital disruption. Digital leaders must integrate work flexibly, emphasizing the use of technology to coordinate work with teachers, students, and parents that are appropriate for the current world. According to the 4C formula (Critical thinking, Creativity, Communication, and Collaboration) prescribed by the Ministry of Education Thailand, one of the keys must be applied to digital leadership in the educational environment. Digital leadership strategies can be implemented through transparent leadership in all aspects of the school.

As seen in the results under discussion, administrators and teachers need to understand the dramatic changes of the digital age that require the development of current technological skills. The digital leadership of administrators should be visible in digital innovation creation, vision, ability to use information systems and technology in practices, and capacity as professional digital users. These are digital competencies emphasized by Pakorn et al. (2022) in the digital leadership model of educational administrators under the Office of the Basic Education Commission, Thailand. The reported model carries seven factors: (i) digital vision, (ii) digital knowledge and skills, (iii) digital management, (iv) digital culture, (v), *digital collaboration networks*, (vi) digital adaptation, and (vii) digital strategies. Of these seven factors (derived from the responses of 360 administrators and teachers in educational institutions under study), the one on *digital collaboration networks* has called attention from administrators regarding the importance networking as an essential characteristic of the digital culture. The Office of the Basic Education Commission has also taken this point into consideration by developing and supporting human resources in the field of education to move forward effectively.

9. Recommendations

Based on the obtained findings, the Area Education Office can accelerate the process of digital leadership training for school administrators by taking four factors into consideration. First of all, *Data Driven* should be promoted and developed for administrators' ability to use information systems and technology via school networks or public/private higher education institution networks for learning and sharing. The next step could be a full-scale learning management in the cyber world in order to reach a high level of digital skills competency.

It is important for schools to organize seminars and training programs to equip personnel with strategies that support the goal and increase competitiveness as a school

with digital innovation. Schools need to increase channels to find various digital learning resources. The short-term and long-term strategic plans should target maximum benefits for quality infrastructure, required communication skills, training programs, information and communication technology systems, and facilities on selected digital platforms. Future research can be pursued in line with the obtained findings on the four identified factors as guidelines for school administrators to achieve digital leadership for effective school management and operations.

10. Acknowledgement

11. The Author

Laddawan Petchroj, Ph.D., is now the Dean of the Faculty of Liberal Arts, Rajapruk University, Nonthaburi, Thailand. She has been well-recognized for her role in major government agencies in Thailand in training scholars and educators in quantitative research. Her areas of research interest include educational management, the use of statistics and data interpretation in quantitative research, strategies for success in training program implementation by private higher education institutions, digital technology and innovation in education, and current issues in the ASEAN networks.

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